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TEXAS BULLNETTLE
and its Control

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SUMMARY

Cattle will avoid areas heavily infested with Texas bullnettle when forage is available elsewhere. Estimates of forage utilization losses range from 14 to 100 percent from bullnettle-infested areas. Control of this perennial weed depends upon destruction of buds located at depths of 3 to 22 inches or more along the stem and on the crown of the tuber (primary root); destruction of the aerial portion causes only a temporary setback of the plant. Quick topkills achieved by strong solutions or oil-based herbicides evidently destroy the cells by which the herbicide is translocated to the roots. Thus, translocation is reduced or stopped, allowing regrowth to occur.

A solution of 0.1 percent 2,4-D amine in water or combined with 0.1 percent picloram and 0.25 percent surfactant killed 85 to 95 percent of the complete plants with one spraying when applied before full bloom. A 0.1 percent solution is achieved with 1 ounce of a 4 pounds per gallon solution of 2,4-D in 3 gallons of water; a 0.25 percent solution results from 2 tablepsoons of surfactant in 3 gallons of water (a 0.1 percent solution by weight is approximately equal to a 0.25 percent solution by volume).

Amitrole induces bud dormancy, as do some other herbicides to lesser extent, but the plant may become active again after 1 to 3 or 4 years. If plants cannot be treated with 2,4-D, they can be destroyed by cutting off the crown of the tuber. All aerial growth buds are located on the crown and on the stem between the tuberous root and the surface. No adventitious growth buds are formed below the crown, but a damaged root system may be replaced by adventitious roots.

CONTENTS

Texas Bullnettle and its Control

P. R. JOHNSON*

BULLNETTLE, *Cnidoscolus texanus* (Muell. Arg.) Small is a vicious, stinging plant of the family *Euphorbiaceae,* having an annual herbaceous top and a large, fleshy underground perennial tuber, or root. It is found in all vegetational areas of Texas except the High Plains (2). Within those areas it is found on the sandy and sandy loam soils, rarely on the clays.

Some authors (1, 5) say the range of closely related *C. stimulosus* (Michx.) Gray extends into Texas, but Marshall C. Johnston, University of Texas Herbarium; Rogers McVaugh, University of Michigan Herbarium; and Grady L. Webster, Department of Biological Sciences, Purdue University (personal communications) all agree that these Texas plants are *C. texanus.* The accepted common name is Texas bullnettle; other names are tread softly, Texas tread softly and mala mujer. The horsenettle (*Solanum carolinense* L.), an entirely different plant, is sometime called ballnettle, or bullnettle and is confused with the true bullnettle.

Several authors (1, 5, 7) have described the aerial portions of the plant but only describe the roots to the extent that they are perennial, long, thick, stout, tuberous, tough or woody. Stewart, Reeves and Jones (8) have given a good description of the complete plant, together with photographs. They reported a root 7.75 inches in diameter and 4 feet long weighing 44 pounds. They also reported small knoblike, fluid-filled glands on the tips of the numerous spines that cover the leaves and branches of the plant. When a person or animal comes in contact with the spines, these glands break off and remain enbedded, and cause an unpleasant sting.

Stewart, et al. (8) reported some field control of bullnettle by placing a solution of white arsenic and lye into the root, but only topkill resulted from spraying the plant with Atlacide. Young (9) reported good topkill with a drenching spray of 0.1 percent solution[1] of 2,4-D LVE, but many plants renewed growth the next year. Johnson (3) found that bullnettles can be controlled with 2,4-D amitrole and 2,3,6-TBA and that the chemicals may induce dormancy for 1 or more years. Klingman (4) emphasized the effective translocation of herbicides to perennial roots when large amounts of food reserves were being moved downward. He also pointed out the fallacy of excessive rates and quick topkills.

Bullnettle Root

In the course of investigations on the control of this weed, several roots were excavated. The underground portion of the plant may be divided into three main parts: the stem, the tuber or primary root, and branch and feeder roots, all of which are perennial, Figures 1, 2, 3 and 6. The large, fleshy, tuberous root is the most conspicuous. Data on several excavated tubers and stems are shown in Table 1. Branch roots usually arise

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[1]Solution percentages are by weight—not by volume.

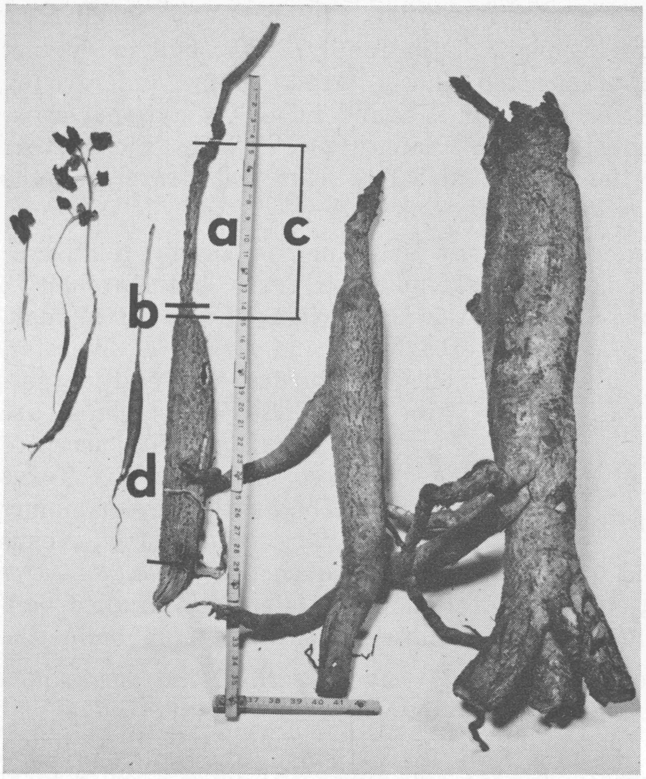

Figure 1. From left: Seedlings, 1-year-old root, other roots of unknown ages. Largest tuber shows remnants of four stems. Legend: A — stem, B — collar, C — bud zone (includes stem and collar), D — tuber.

near the base of the tuber, Figure 1, but may be found nearer the crown. In outward appearance and in cross section, branch roots are similar to the main tuber. The small feeder roots are light brown in color, threadlike and are brittle. Usually, only short sections of feeder roots can be removed without breaking.

The "usual" tuberous root is somewhat carrot shaped, being round, tapering from top to bottom and with few branch roots except at or near the bottom, Figures 2 and 3. The shape is largely determined by soil conditions. Deep, loose sand is conductive to long, smooth tubers, while shallower sandy loam with clay subsoil is conductive to short, thick, stubby tubers. Large rocks in the soil may cause the tubers to be short or to have more branches, Figure 2.

In cross section the tuber shows rings similar to annual growth rings of trees, Figure 4. Stewart, et al. (8) suggested that these were growth rings, but attempts to correlate the rings with age failed. Young roots of known or closely estimated age might show more than one ring per year, while inability to determine age of older roots precluded their use. It may be that these concentric rings are storage parenchyma and have no correlation with age. Similar rings were found by Myers, Beasley and Derscheid (6) in roots of *Euphorbia esula* L.

The crowns of the tubers were found from 3 to 22 inches below the soil surface. Stewart, et al. (8) reported a crown 27 inches below the surface and concluded that as the root grew older it contracted and the crown sank. This assumption must be true for the first years of the plant's life, as the crown is formed near the surface initially. Other undetermined factors also influenced the depth of the crown. In one series of 69 roots excavated from pasture in which the soil had not been disturbed for approximately 30 years, there was a range of 3 to 18 inches in the depth of the crowns. Diameter of the root was taken to be indicative of the relative age of the plant. The root diameter was insignificantly and negetatively correlated with depth of the crown, $r = -.0411$.

One or more stems may develop from the crown. The buds from which the annual aerial growth develops arise from the stem or from buds on the crown. Usually only one to three or four buds will produce aerial growth in a season, and these will be the buds nearest the soil surface. When part of the stem or the crown and stem is exposed, the aerial growth will develop from the lower buds and the exposed stem will die.

No aerial growth buds have been found lower than the crown. Attempts to induce initiation of buds at lower levels by removing the crown have not been successful. This has been true for roots left in place as well as for those transplanted to the greenhouse.

The localization of aerial growth buds on the crown and stem suggested that the plant could be controlled by mechanically cutting off the crown and leaving the rest of the root in place. No aerial buds developed on manually decapitated roots after 3 years or on roots with chemically destroyed growth buds after 4 years, Figure 5. Where decapitation was incomplete, new stems developed from remaining buds, Figure 3.

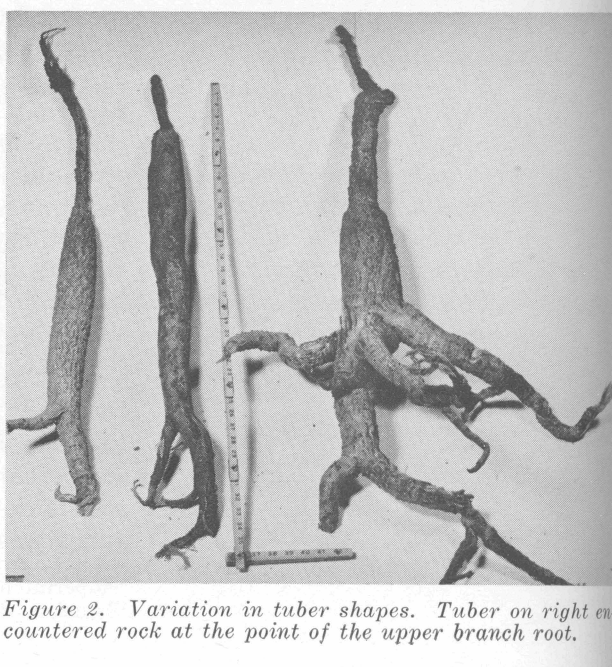

Figure 2. Variation in tuber shapes. Tuber on right encountered rock at the point of the upper branch root.

Figure 3. Normal shape and location of branch roots. Gopher had destroyed part of crown; there is spade injury below crown.

Root growth from adventitious buds was demonstrated in the greenhouse and in the field, Figures 6, 7 and 8.

Two roots cut off ½ inch and two cut off 1½ inches below the crown on July 25, 1962, failed to develop adventitious roots on the crown portion. They did make some aerial growth during 1962 but not in 1963 or 1964. When examined on August 24, 1964, they were decayed, with no evidence of root formation. Two roots cut off 3 inches below the crown and potted in the greenhouse formed adventitious roots and continued aerial growth, Figures 6 and 7. This would suggest that if control by cutting off the crown is practiced the crown should be left uncovered and allowed to dry out. Deep plowing with a moldboard plow would cut some previously undisturbed roots below the crown, and the crowns might form new plants. However, no plants so propagated have been identified in the field.

TABLE 1. SOME CHARACTERISTICS OF BULLNETTLE TUBERS

Characteristic	Number of tubers examined	Average	Range
Depth of crown from surface	105	8.8 inches	3 - 22 inches
Stem length	83	2.7 inches	0.75 - 10.0 inches
Diameter of tuber at top	139	2.9 inches	1.0 - 5.8 inches
Diameter of tuber at bottom	95	1.8 inches	0.5 - 4.5 inches
Length of tuber	117	18.6 inches	9 - 52 inches
Weight of tuber	94	3.8 pounds	0.1 - 20.7 pounds
Volume of tuber	93	105.4 cu. in.	5.8 - 566.4 cu. in.
Number of buds on crown	31	5.1	0 - 18

Buds on the crown and stem, except for one to four of the uppermost, remain dormant unless exposed to light. This characteristic was used to distinguish between dormant buds and those dead from herbicide or other causes during January and February of 1965.

Two lots of 19 and 77 tubers were stacked in horizontal layers with crowns exposed on a soil bed in the greenhouse. They were covered with clear polyethylene and kept moist. Minimum night temperature was 60 degrees F. and maximum day temperature with bright sun was 85 to 90 degrees. All viable buds commenced growth within 15 to 20 days. Number of viable buds on the crowns ranged from none to 18.

Viable and dead buds also may be distinguished macroscopically by cutting away the bark and the bud scales and examining the meristematic tissues. This method is tedious and possibly less accurate than by forcing growth.

Aerial Plant

The annual aerial plant emerges from the perennial root and stem system at approximately the average date of last killing spring frost.

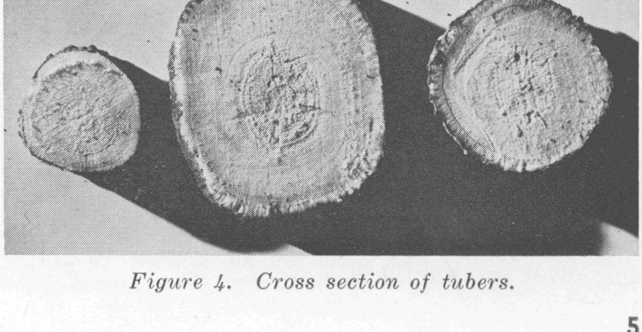

Figure 4. Cross section of tubers.

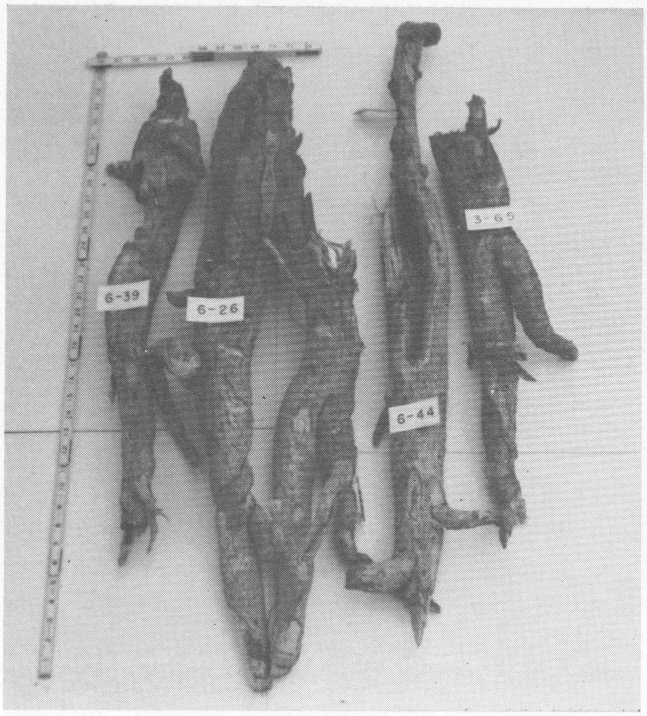

Figure 5. Herbicide damage to stems, crowns and side of tubers. Plants were sprayed in 1960 and tubers were removed from soil in 1964. No aerial growth occurred following spraying.

Emergence usually is complete 60 to 75 days later. Plants cut off near the surface will resprout up to August or later. One to four stems may emerge from a single root system, and occasionally two or three roots may be growing in such close proximity that several stems appear to arise from the same root.

Early growth is upright; older plants are much branched and semi-erect with a horizontal spread up to 54 inches and height up to 30 or 36 inches. Size of the plant is not indicative of root size after the first few years. Growth of undisturbed plants usually is complete by late August or September, and they often die down before frost in early fall.

Leaves are large, deeply lobed (3-5, mostly 5-lobed), roundish-cordate, alternate and on long petioles. Late season leaves sometimes are discolored yellowish or chlorotic. The flowers are monoecious, white, fragant, about 1 inch across and on a terminal cyme. The pistillate flower is on a short stalk and has a three-celled ovary surrounded and over-topped by staminate flowers on longer stalks. There are from one to four of these pistillate-staminate groups in each flower cluster.

Stems, branches, petioles, leaves and seed capsules are covered with white, stiff, stinging hairs or spines. On the leaf the spines are practically all on the midrib and veins, with some between the veins. They are on both the upper and lower leaf surfaces.

Figure 6. Adventitious roots on upper 3-inch section of tubers.

Propagation

Bullnettles are propagated by seed. These are large, bluntly oval, 11/16 inch long by 5/16 to 7/16 inch wide and average 0.32 grams weight each, or about 1,400 per pound. They are borne in a three-locule capsule which dehisces on maturity with considerable force. A seed from a capsule on an office desk struck a filing cabinet 6 feet away, and another from the same capsule was thrown behind an open door 54 inches higher than the desk and 8 feet from the point of origin. Seedlings have been found 15 feet from any seed-producing plant.

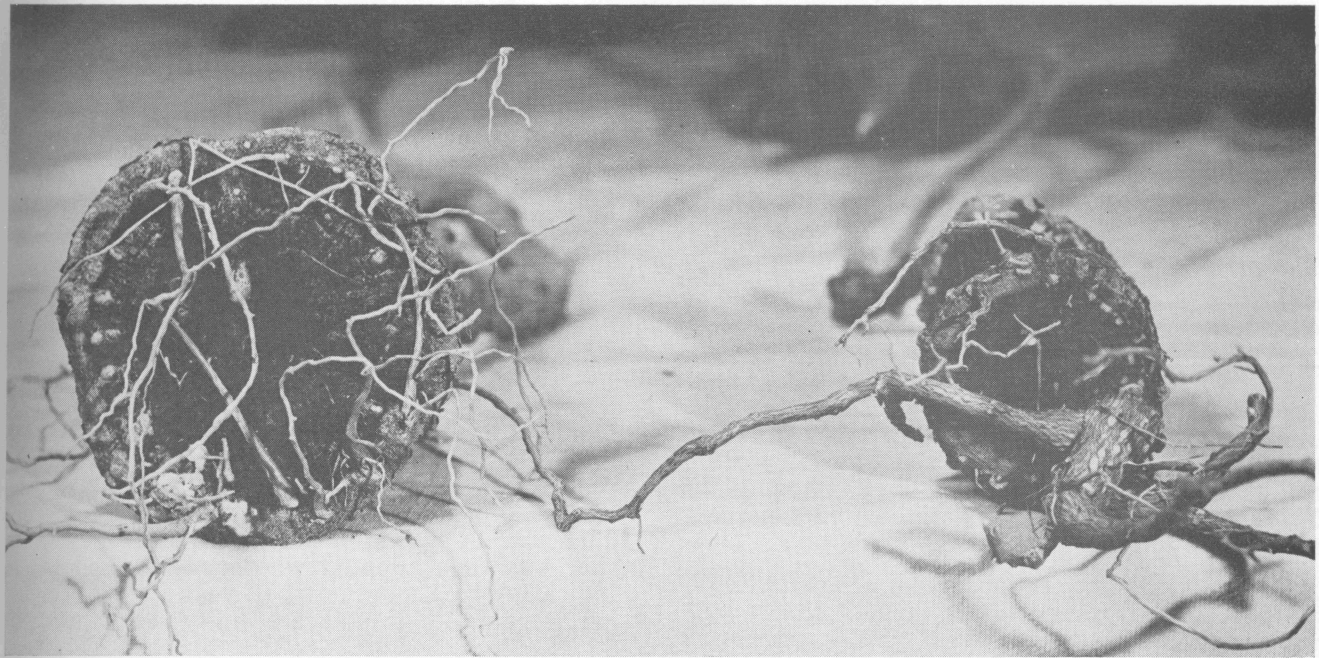

Figure 7. Location of adventitious roots. Same tubers as in figure 6.

Squirrels and possibly other wild animals and birds eat the seed and may disseminate them. In cultivated fields young seedlings have emerged from depths of 1 to 4 inches.

Parasites

The only parasite found to attack the roots is the pocket gopher. The crown, stem and aerial parts are eaten; no tuber has been found with the crown completely destroyed. Enough buds were left to reestablish the plant. The stems and tops apparently are completely eaten. Tops were observed being pulled into the ground as is typical of this rodent when eating aerial plants. Roots were uncovered with gopher runs contacting the root below the crown, then turning up to and over the crown. Gopher tooth marks on partially decapitated roots further identified the parasite. It has not been possible to determine the amount of damage done to bullnettle by gophers. The gopher population level would be an important consideration. These investigations were conducted with a light infestation. Damage done to underground parts can be assessed only by

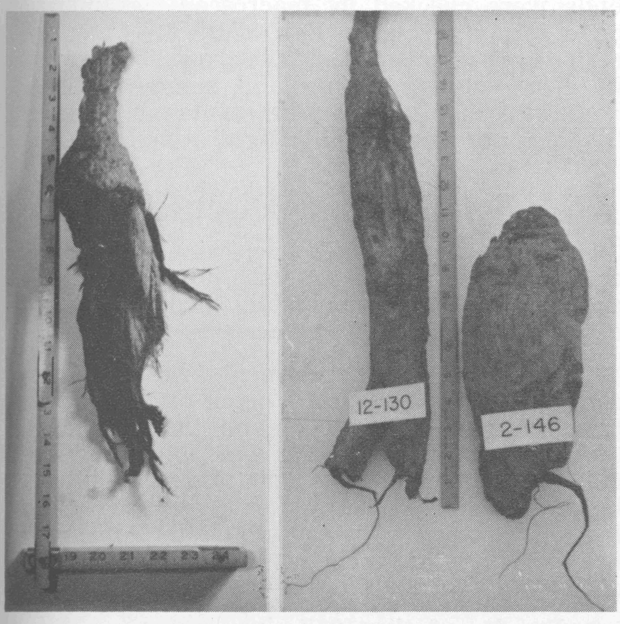

Figure 8. Root decay from bottom upward. Plant at left was sprayed June 13, 1961 and removed July 25, 1962. Decay probably would have involved the entire root if left undisturbed. Plants at right were sprayed June 13, 1961 and removed Dec. 16, 1964. Adventitious roots were formed, viable buds were present and small aerial growth occurred in 1964, but not earlier.

Figure 9. Animal did not graze within spread of bullnettle plant.

TABLE 2. EFFECT OF BULLNETTLE ON PRODUCTION AND UTILIZATION OF COMMON BERMUDAGRASS

	Yield, pounds per acre[1]				Percentage of caged bermudagrass			
Source of sample	5/31/61 to 8/23/61	4/1/62 to 5/28/62	5/28/62 to 8/6/62	8/6/62 to 10/22/62	5/31/61 to 8/23/61	4/1/62 to 5/28/62	5/28/62 to 8/6/62	8/6/62 to 10/22/62
Grass, protected by cages	5880	2701	3615	2252	100	100	100	100
Grass, in open, grazed	1568	1655	610	305	26.7	61.3	16.9	13.5
Grass, protected by bullnettle	4530	3006	1437	2178	77.0	111.2	39.7	96.7
Grass, protected by bullnettle and cage			2788	2091			77.1	92.8
Bullnettle, in open	871	1002	1699	871				
Bullnettle, protected by cage			566	52				

[1]Yields in the designated areas; effect on larger areas would depend on stand of bullnettle.

uncovering and examining the growth buds on the stem and crown; that to the aerial portion can be assessed only if part of the damaged plant is found. Some evidence has indicated 4 percent of the tops killed.

Few insects were observed attacking bullnettle. A long-horned beetle larve (*Ataxia* sp.) was found in a dead aerial stem. Fall armyworms and grasshoppers were observed eating forage, but only when other vegetation was limited.

Grass Production and Utilization Near Bullnettle

Cattle will avoid an area heavily infested with bullnettle when adequate forage is available elsewhere. Even when animals do graze among the plants, the grass growing near and within the spread of the plant is left, Figure 9. When grazing pressure is heavy, grass leaves developing above the nettle may be utilized. In order to estimate the grazing loss caused by bullnettle, yields were estimated using a series of cages in quadruplicate in an infested pasture. The yields are shown in Table 2. It is difficult to determine the effect of the nettle on grass production. Data indicate that during spring and fall as much grass is produced within the spread of the nettle as in the open. Grass production appears to be reduced 20 to 60 percent during the summer.

A moderate stand of bullnettle may be 650-750 per acre. Since an average plant will cover an area of 12.5 square feet, 700 plants would cover 8,750 square feet or approximately one-fifth acre. Thus, a major loss in utilization would occur even if grass growth was not significantly depressed.

Materials and Methods for Control

Natural stands of bullnettle were used throughout the study. The plants were of varying ages, and no satisfactory way of determining ages after the first few years is known. After the first 3 years the younger plants were not included in the test.

Initially, the work was conducted on a plot basis, but this was not fully satisfactory in that plant locations could not be maintained for those roots that did not produce new top growth the year following treatment. Some roots were considered killed when in fact they were merely dormant. A system of individual plant identification was then adopted whereby embossed labels indicating treatment number, year and plant number were nailed to stakes beside each plant.

Plants were individually sprayed at 30 or 40 psi to the point of spray run-off. A surfactant was used only in 1964. The amount of solution used per plant varied with size and averaged one-fourth pint. Chemicals evaluated in these studies are listed in the tables. Common names accepted by the Weed Society of America are used for the herbicides included. The full chemical names are given in the Appendix.

Plants in the numbered series were classified as dead or dormant after excavating the plant site and finding evidence of a decayed root, or examining the crown and stem buds. Doubtful buds were checked by macroscopic examination or by forcing growth. Part of the 1964 numbered series were uncovered and the crowns left exposed, in place, during spring and summer of 1965. Some of the amitrole-treated plants may have been too dormant to respond to light stimulation.

Results and Discussion

Plants were mowed once, twice or three times each year for many years with no apparent effect on population. Plant reestablished rapidly when cut off above the soil surface.

Some chemical treatments have the same effect as mowing in that a quick top kill prevents translocation to the roots and the buds on the stem and tuber crown. It was shown by Klingman (4) in his review of the literature on translocation of herbicides that extremely toxic chemicals or excessive rates will stop translocation to the roots with much the same effect as cutting off the top.

Results of the 1957 spray treatments are shown in Table 3. Plots in triplicate were sprayed August 13, 1957. One replication had been mowed on June 5; the regrowth was maturing. The other two replications were mowed on July 12, and the regrowth was in bloom when treated.

TABLE 3. THE EFFECT OF CHEMICAL TREATMENTS ON BULLNETTLE, 1957 CUTHBERT GRAVELLY SANDY LOAM SOIL

Treatment			Number of plants[1]		
Chemical	Carrier	Pounds of chemical per 100 gallons	sprayed 8/13/57	surviving 6/19/58	Apparent survival (percent)
Silvex	diesel oil	4 pounds	128	128	100
Silvex	diesel oil	8 pounds	159	149	94
Silvex	water	4 pounds	133	140	105
Erbon	diesel oil	4 pounds	135	147	109
Erbon	diesel oil	8 pounds	154	150	97
Erbon	water	4 pounds	130	140	108
Amitrole	water-oil-Fab	4-95-5-1	170	87	51
Amitrole	water-oil-Fab	8-95-5-1	158	73	46
2,3,6-TBA	water	4 pounds	155	148	95
2,3,6-TBA	water	6 pounds	154	176	114
Diesel oil			114	138	121

[1]Counts included seedlings.

Stand counts were made on August 12, before spraying, and 10 months later on June 19, 1958. Both counts included some seedlings, so the possibility remains that unsprayed seedlings were counted in 1958 that were not included in the 1957 count. The near 100 percent survival on all except the amitrole plots shows the ineffectiveness of the treatments. Stage of growth when sprayed had no effect on the results. Later results indicate that much of the apparent kill with amitrole was simply induced dormancy. Applications of 2,3,6-TBA in 1960 showed that the 1957 rates of this material were too low for effective control. Other observations have shown that gasoline, kerosene and naptha along with diesel oil are unsatisfactory carriers of herbicides for bullnettles because of the quick topkill by these materials.

The 1959 and 1960 treatments and results are shown in Table 4. The plants were sprayed in the full bloom stage June 29, 1959 and early bloom stage June 3, 1960 using the same plots. Treatments were also the same each year except that liquid amitrole was used in 1960 instead of 2,3,5,6-TBA, and 0.1 percent 2,4-D amine was used instead of 0.5 percent 2,4-D LVE. Plant counts on June 29, 1959 included an unrecorded number of seedlings. Mortality among the seedlings was high, making the apparent control look better than it really was. Later counts separated seedlings and young plants from older plants, and survival percentages are based on old plants. There also was a small undetermined amount and distribution of seasonal loss due to gophers.

Amitrole continued to show good control for the season of application and the year following. During the third year after application several plants emerged from roots that were dormant for 2 years. The characteristic of dormancy, rather than control, following the application of amitrole and some other materials also was found in later investigations. The 2,3,5,6-TBA was not satisfactory for bullnettle control. Later comparison of another benzoic acid on two soil types showed better control on the more sandy soils. Soil on parts of the 1959-60 plots was comparatively shallow. The rate of application was later found to be too low. 2,4-D generally gave satisfactory control, except that high rates gave quick kill and apparently did not allow sufficient translocation to the root. The amine formulation apparently was better than the ester.

Control based on semi-permenently identified plant locations is illustrated in Tables 5 and 6. The treatments were applied to 50 plants each in 1960 and 1961. Records of regrowth were made twice yearly until the fall of 1964. Each plant site was excavated and the condition of the tuber noted. Tubers in various stages of decay were recovered, and open holes from which the root had decayed were found. Decay often started at the bottom of the primary root and progressed upward. In some instances decay apparently was arrested and the plant was recovering, Figure 8. In other instances the bud zone at the collar and on the stem was destroyed, in which case no further aerial growth was made, Figure 5. Various other degrees and locations of partial decay also were found. Viability of the buds was determined on roots which were recovered. Plants were classified as dead when the buds were dead, the bud zone was destroyed or when the root

TABLE 4. THE EFFECT OF CHEMICAL TREATMENTS ON BULLNETTLE PLANTS

Material and formulation	1959-60 Number of plants sprayed 6/29/59[1]	1959-60 Number of plants found 6/1/60	Apparent percent survival 6/1/60	1960-1962 Number of plants sprayed 6/3/60	1960-1962 Number of plants found 5/28/62	Apparent percent survival to 5/28/62 from 6/29/59	Apparent percent survival to 5/28/62 from 6/3/60
2,4-4 LVE .1 percent	261	50	19	50	40	15	80
2,4-D LVE .25 percent	187	53	28	53	25	13	47
2,4-D LVE .50 percent	178	81	46				
2,3,5,6-TBA 4/100	172	77	45				
2,3,5,6-TBA 8/100	210	126	60				
Amitrole 4/100	223	17	8	17	65	29	382
Amitrole 8/100	182	21	12	21	29	16	138
Check—not treated	243	158	65	158	154	63	97
2,4-D Amine .1 percent				81	35	20	43
Amitrole, liquid, 4/100				77	34	20	44
Amitrole, liquid, 6/100				126	16	8	13

[1]Count on 6/29/59 included seedlings, most of which failed to survive. Count on other dates are of old plants only.

TABLE 5. CONTROL OF BULLNETTLE PLANTS 4.5 YEARS AFTER SPRAYING SECOND-GROWTH PLANTS JULY 12, 1960, BOWIE AND KIRVIN FINE SANDY LOAM SOILS

Material and formulation	Number of plant locations	Percentage of roots and open root holes located[1]: Roots decayed	Stem, and crown decayed	Crown not decayed: Buds dead	Crown not decayed: Buds viable	Dormant for 1 or 2 years, growing in 1964	Live plants not dormant	Total percent dead plants
2,4-D Amine, 0.1 percent	44	64	7	9	4		16	80
Amitrole, powdered, 4/100	41	44	12	7	24		12	63
Check[2]	48						100	0
2,3,6-TBA, 1 gm./plant	42	40	5	2		7	45	47
2,3,6-TBA, 2 gm./plant	48	77	2		4	2	15	79
2,3,6-TBA, 3 gm./plant	48	90	2				8	92
2,3,6-TBA, 4 gm./plant	50	90			2		8	90

[1]October 15 and December 16, 1964.
[2]As of 7/24/62, area taken by highway.

had decayed completely. Where viable buds were found, even though no growth had been made for 3 or 4 years, the plant was classified as dormant and potentially able to reestablish itself.

The treatment of 0.1 percent 2,4-D amine resulted in 80 percent and 70 percent control for the 1960 and 1961 sprayings, respectively, and was better than the LVE formulations. This control was exceeded by 2,3,6-TBA at 3 and 4 grams per plant during 1960, but 2,3,6-TBA was not satisfactory in 1961 on shallower, less sandy soils. The 2,3,6-TBA and other benzoic acid formulations acted partially through leaf absorption and partially through root absorption. On the shallower soils the feeder roots were largely in clay which the herbicide penetrated sparingly or not at all. The amitrole products induced bud dormancy more than any other material. Counts of plants emerged 12 or 24 months after spraying indicated outstanding control, but some plants emerged during the third year after spraying, and even longer dormancy and emergence is possible. Aerial parts that emerged from dormant buds of amitrole-sprayed plants showed distinctive discoloration caused by this material during the early stages of growth, but changed to normal green 2 to 4 weeks after emergence. Emergence from dormant buds occurs at any time during summer.

Another series of staked plants were sprayed on June 22, 1964, in order to test picloram (Tordon) and dicamba (Banvel D), in comparison with previously tested materials. The plants were in one-half to full bloom. Many sites were lost, but those that could be located were excavated January 29, 1965. Roots were left in place but with the crown uncovered throughout 1965. Control evaluated solely on completely decayed roots was very good for 0.25 percent 2,4-D LVE and 0.1 percent 2,4-D amine. The other materials and combinations produced less favorable results, Table 7. The amitrole treatment resulted in 95 percent of the roots being classified as having dead buds, but previous experience with this material raises doubt as to the accuracy of the classification. Very good apparent control based on decayed roots plus apparently dead buds was obtained with picloram, picloram-2,4-D combinations and dicamba.

Results of spraying unstaked plants on definitely outlined areas during 1964 are shown in Table 8. Picloram and picloram-2,4-D amine gave very good results based on counts made 12

TABLE 6. CONTROL OF BULLNETTLE PLANTS 3.5 YEARS AFTER SPRAYING JUNE 13, 1961, CUTHBERT AND KIRVIN GRAVELLY SANDY LOAM SOIL

Material and formulation	Number of plant locations	Percentage of roots and open root holes located[1]: Roots decayed	Stem, and crown decayed	Crown not decayed: Buds dead	Crown not decayed: Buds viable	Dormant for 1 or 2 years, growing in 1964	Live plants not dormant	Total percent dead plants
2,4-D LVE, 0.1 percent	50	24					76	24
2,4-D LVE, 0.25 percent	43	58		2			39	60
2,4-D Amine, 0.1 percent	47	64		6		6	23	70
Amitrole, liq., 4/100	46	50		17	26	2	4	67
Amitrole, liq., 6/100	48	50	2	10	25	6	6	62
Amitrole, powd., 4/100	42	50	2	7	31	7	2	59
Amitrole, powd., 6/100	43	33		19	28	19	2	52
Check	49		2				98	2
2,3,6-TBA, 2 gm./plant	36	19		3		22	55	22
2,3,6-TBA, 3 gm./plant	47	23	2	6	2	6	60	31
2,3,6-TBA, 4 gm./plant	45	29	4		2	7	58	33

[1]December 16, 1964

TABLE 7. CONTROL BASED ON ROOT EXAMINATION: SPRAYED 6/22/64, EXPOSED 1/29/65

Material and formulation[1]	Number of plant locations	Roots decayed percent	Roots located and uncovered: dead percent	Roots located and uncovered: buds alive percent	Apparent percent control
2,4-D LVE, 0.25 percent	20	90	5	5	95
2,4-D Amine, 0.1 percent	28	86	11	3	97
Amitrole, 4 lb./100 gal.	41		95	5	95
Picloram, 0.1 percent	16	31	56	13	87
Picloram, 0.1 percent 2,4-DA, 0.1 percent	23	61	35	4	96
Dicamba, 4 lb./100 gal.	23	35	52	13	87

[1]0.5 percent X-77 surfactant added to each formulation.

months later. When older plants were sprayed with 0.2 percent picloram the control was less than that obtained with young plants and weaker solutions.

The control obtained with a surfactant was as good or better than that obtained previously without it, so the effectiveness of the material was not diminished and possibly was enhanced.

Some essentials to satisfactory control were consistently apparent in these studies. Young, growing plants were easier to kill than older ones. Plants that have passed the full bloom state should be mowed and the regrowth sprayed. A weak solution of a hormone-type herbicide using a water carrier is preferable to stronger solutions and those resulting in a rapid topkill. Soil texture is related to effective control by 2,3,6-TBA; plants on sandy soil are killed more readily.

TABLE 8. CONTROL BASED ON REGROWTH OF PLANTS IN AREA THE FOLLOWING YEAR

Material formulations[1]	Date sprayed	Number of plants sprayed	Number of plants found 6/30/65	Apparent percent control
Picloram, 0.1 percent, 2,4-DA, 0.1 percent	6/23/64	93	11[2]	88
Picloram, 0.1 percent, 2,4-DA, 0.1 percent	8/24/64	48	5	90
Picloram, 0.1 percent	8/24/64	33	5	85
Picloram, 0.2 percent	8/25/64	51[3]	23	55

[1]0.25 percent X-77 surfactant added to each formulation.
[2]6/14/65.
[3]Mostly old and inactive plants.

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APPENDIX

Common and Chemical Names of Herbicides Used

Common name	Brand names[1]	Chemical name
Amitrole	(Various)	3-amino-1,2,4-triazole.
Dicamba	Banvel-D	2-methoxy-3,6-dichlorobenzoic acid.
Erbon	Baron	2-(2,4,5-trichlorophenoxy) ethyl-2,2-dichloropropionate.
Picloram	Tordon	4-amino-3,5,6-trichloropicolinic acid.
Silvex	Kuron	2-(2,4,5-trichlorophenoxy) propionic acid.
2,4-D amine	(various)	Alkanolamine salts (of the ethanol and isopropanol series) of 2,4-dichlorophenoxyacetic acid.
2,4-D LVE	(various)	2,4-dichlorophenoxyacetic acid, propylene glycol butyl ether ester.
2,3,6-TBA	Trysben 200	2,3,6-trichlorobenzoic acid.
2,3,5,6-TBA	Benzac 354	Dimethylamine salt of tetrachlorobenzoic acid—20 percent, Dimethylamine salt of trichlorobenzoic acid—15.2 percent, Dimethylamine salt of other polychlorobenzoic acid—12.5 percent.

[1]Brand names are given for information only.

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